J. Glob. Innov. Agric. Soc. Sci., 2014, 2(2): 70-75.
ISSN (Online): 2311-3839; ISSN (Print): 2312-5225
DOI: 10.17957/JGIASS/2.2.511
http://www.jgiass.com

PREVALENCE OF OSTEOPOROSIS IN RELATION TO SERUM CALCIUM AND PHOSPHORUS IN AGING WOMEN

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Osteoporosis is increasingly being recognized by the medical fraternity as a significant health problem. This research was designed to study the incidence of osteoporosis in post-menopausal women and its relation to body mass index, body muscles, body fat and mineral status (calcium and phosphorus). Thirty samples of post-menopausal women aging between 45-60 years were divided into 3 groups. Body weight and height seemed to be tested through the use of electronic weighing balance and Stadiometer. Body muscles and fat percentage were determined through Beurer GmBH BLACK Blr.64. Bone mineral density was calculated by bone densitometry. Serum concentration of calcium and phosphorus was determined by spectrophotometer. The data obtained was subjected to Analysis of Variance. Results showed the significant decrease in body muscle, bone mineral density and serum calcium with increasing age. It was concluded that body weight, body muscles, body fat, bone mineral density, serum calcium and phosphorus had significant association with age and osteoporosis. Body fat and serum phosphorus increases with age in post-menopausal women. Body mass index and height had non-significant association with age and osteoporosis.
Keywords: Osteoporosis, Serum Calcium, Phosphorus, Aging Women

INTRODUCTION

Osteoporosis is a metabolic syndrome of bones in which bones become so weak and incapable to support the body due to loss of both minerals and bone matric in equal proportions (Hinjorgo *et al*., 2008). It sets during the later years but it develops much earlier without cautioning. It is most rampant disease of aging that has affected more than 25 million people commonly women in all over the world. People are hospitalized due to osteoporosis each year in United States (Whitney and Rolfes, 2002).

Osteoporosis seems to be a considerable issue in Pakistan. There are major nutritional (calcium and vitamin D) concerns. An approximation based on an ultrasound study across Pakistan, implies the number of people with osteopenia at 40 million (almost same numbers of men and women), having virtually 10 million weak bones. Women aged 45-70 years, the prevalence regarding osteoporosis and osteopenia has been observed for being 16 and 34%, respectively (Sultan *et al*., 2006). In KP Province a same review showed an epidemic of 29 and 42% (Lowe *et al*., 2008).

More than two hundred million people worldwide suffer from osteoporosis. In older adults the pervasiveness of osteoporosis is enduring to escalate with increasing age. An increase in frailty fractures is the primary complication of osteoporosis leading to mortality, morbidity and poor worth of life. Throughout the European Union, within 2000, the volume of osteoporotic bone injuries had been estimated from 3.79 million. A baseline bone fracture is often a quite strong predictor involving additionally bone injuries along with 20% patients enduring a 2nd bone fracture within just the initial year. The prices to health providers upon existing styles usually are forecast to be able to twice through 2050. This direct fee involving osteoporotic bone injuries towards the health and fitness providers in the European Union within the year 2000 were estimated at 32 billion Euros. In many countries strategies are available for the diagnosis and management of osteoporosis but implementation is usually poor although the treatments are available with verified efficacy (Reginster and Burlet, 2006).

Bone strength reveals the incorporation of two major features: bone quality and bone density (National Institute of Health, 2000). Although before treatment, bone mass density (BMD) is the standard test for the analysis of osteoporosis, recent research specifies that measurement of BMD alone may not be satisfactory for evaluating the risk of fracture and for cure efficiency. Bone quality may be a more useful concept which indicates the assimilation of BMD and bone strength. Material and structural properties determine the bone strength and effect of overall quality of bone (Link and Mujamdar, 2003).

In normal process of bone turn over the rate of bone resorption and bone formation is equal in which by acidification osteoclasts remove bone and by secreting osteoid into the resorption cavity osteoblasts build bone. The rate of bone turnover is increased due to elongation of the life span of osteoclasts and reduction in the lifespan of osteoblasts (Manolagas, 2000). Bone mass is a main determining factor of bone density in an elder individual. Though the acquirement of highest bone mass begins in mother womb and is usually complete by age forty, the amount of bone that is gained during puberty is the main contributor to this process (Mora and Gilsanz, 2003). Bone

loss accelerates in the latest years after cessation of ovarian function at menopause and bone mass endures to decline with age (Hannan *et al*., 2000). So, in addition to peak bone mass, older age it is a risk factor for bone loss. Small percentage of body fat, low body weight or low BMI causes the rapid bone loss and low bone mass which are independent causative factors to post-menopausal osteoporosis (Lane, 2006).

Dual Energy X-ray Absorptiometry (DEXA), peripheral dual energy X-ray absorptiometery (P-Dexa), Dual Photon Absorptiometery(DPA), Ultrasound and Quantitative Computed Tomography (QCT) are different methods for the measurement of bone mineral density. Dual energy x- ray is the most accurate way and DEXA results are described in terms of T-score. T-score that indicates osteoporosis is -2.5(Leslie *et al*., 2008).

Supplementation of vitamin D and calcium has positive effect on bone mineral density. Dietary intake assessment method was used to check the calcium and vitamin D intake while dual energy X-ray absorptiometry was used to calculate the whole body and segmental bone mineral density. It was observed that vitamin D and calcium supplements are needed to stop bone loss in women after menopause and delay the onset of osteoporosis (Daniele *et al*., 2004).

Diet and physical activity play significant role in bone strength. Exercise is critical for maintaining normal bone mass. Enormous amount of phosphorus and calcium in the diet is essential for bone health. Appropriate functioning of hormones is the final essential item for bone health that affects the phosphorus and calcium supply and the formation and interruption of bone. Parathyroid hormone, estrogen, calcitonin, calcitriol, thyroid hormone, growth hormone and cortisol are important hormone of bone health (Anonymous, 2004).

Calcium level in the blood is control by parathyroid hormone. It also activates formation and resorption of bone. An insufficient intake of calcium and vitamin D affect calcium-regulating hormones. Deficiency of these nutrients results in poor calcium absorption and decreases the level of serum ionized calcium. Lower concentration of serum calcium enhances the secretion of Parathyroid Hormone (PTH) and its elevated level leads to secondary hyperparathyroidism; a condition that increases the process of bone remodeling leading to momentous loss of bone and increased risk of fractures (Nieves, 2003).

Vitamin D is required for achieving maximum bone health throughout life. It enhances the absorption of calcium in small intestine and important in mineralization of bone (Holic, 2002). Bones become skinny, fragile and soft or deformed due to increased pervasiveness of hypovitaminosis D. 70-80 nmol/L is the normal serum level of 25-hydroxyvitamin D. (Vieth, 2005). This serum level and higher dietary intake of vitamin D are significantly related with reduced risk of osteoporosis (Holick, 2005). Severe deficiency of vitamin D and low bone mineral density in women is indicator of osteoporosis (Islam *et al*., 2008).

Although osteoporosis is more common in females as compared to males about one in three women and one in five men bear this incidence (International Osteoporosis Foundation, 2005). After menopause estrogen level is decreased that leads to swift reduction of bone mass in females and increase the risk of osteoporosis (Riggs *et al*., 2002).

As the prevalence of osteoporosis and associated fractures differ from country to country, a lot of factors except menopause may be liable for the conflicting incidence. For primary postmenopausal osteoporosis, the non-modifiable risk factors are female sex, hormonal changes, family history of osteoporosis, early menopause and older age while amendable factors include low calcium intake, alcohol, modest physical activity, smoking and lower body weight (Snelling *et al*., 2001).

Nutrition is vital for bone health. Vitamin and minerals plays a key role in the prevention osteoporosis. But the maximum level which is tolerated in food or as dietary supplements is not recognized. The benefits of supplementation of vitamin D and calcium on population at risk of osteoporosis are well-known. Supplementation of vitamin D and calcium in older people inhibit bone loss and prevent fragility fractures. Though phosphorus is necessary to bone health a normal consumption is considered to be more than satisfactory but further supplementation causes injurious effects on health. (Bonjour *et al*., 2009)

Treatments of osteoporosis include vitamin D and calcium supplementation (Tang *et al*., 2007), Weight bearing exercise (Bonaiuti *et al*., 2002), hormone replacement therapy, use of pharmacological agent such as biphosphate, raloxifene, selective estrogen receptor modulators and calcitonin (MacLean *et al*., 2008).Professional recommendation and monitoring is necessary for these patients (Keen, 2007).

The main objectives of the study were to assess the prevalence of osteoporosis and the mineral status (Ca and P) in aging women. The relationship between bone mineral density, calcium, phosphorus and BMI was also determined.

MATERIAL AND METHODS

The present study was conducted on post-menopausal women. Total 30 post-menopausal women aging between 45-60 years were selected as sample and they were divided into 3 groups. Group 1 includes women aging between 45-50 and group 2 includes women aging between 51-55 and group 3 includes women aging between 56-60.The research trial was carried out at National Hospital, Faisalabad and samples were analyzed in the Rifha Laboratories, Faisalabad. The anthropometric measurements were taken following the methodology described by Visscher *et al*. (2000). Age of each sample was recorded in years described by them. Body weight and height was measured barefooted and lightly dressed by using electronic weighing balance and stadiometer (Chumlea *et al*., 1990). BMI was calculated by using the given formula (Visscher *et al*. 2000).

$$BMI = \frac{Weight\ (kg)}{Height\ (m^2)}$$

Body muscles and fat percentage was determined through Beurer GmBH BLACK Blr.64. Bone mineral density was calculated by bone densitometry (Kanis *et al*., 1994). Commercially available human Gasellschaft biochemical and diagnostic kit was used to determine the serum concentration of calcium by spectrophotometer (Barnett, 1973). Concentration of serum phosphorus was determined by using commercially available human Gasellschaft biochemical diagnostic kit. For the interpretation of results, data collected were subjected to statistical analysis using analysis of variance techniques. Means of treatment were compared by Duncan's new multiple range test (Steel *et al*., 1997).

RESULTS

Data showed that the weight range (65.01±1.00 to 73.44±2.60), body fat, bone mineral density and phosphorus of post-menopausal women was significantly ($P<0.01$) increased in 56-60 and low in 45-50 age group. Body fat and calcium was observed significantly ($P<0.01$) increased in 45-50 and low in 56-60 age group. While, there were non-significantly difference in height and body mass index compare with age in aging women (Table 1).Correlation matrix table between age and weight, height, body mass index, body muscle, body fat, bone mineral density, calcium and phosphorus compared with age in post-menopausal women was showed described in table 2.

Data showed that the association of mean of age, body fat, calcium and phosphorus was found significantly different. However, there was non-significantly difference in weight, height, BMI and body muscle compare with bone mineral density in post-menopausal women (Table 3). There was non-significantly difference in age, height, body muscle, body fat, bone mineral density, calcium and phosphorus compared with body mass index in post-menopausal women (Table 4).

DISCUSSION

The present study was conducted to study the prevalence of osteoporosis in relation to serum, calcium and phosphorus in aging women. Osteoporosis is metabolic syndrome of bones in which bones become so weak and incapable to support the body due to loss of both minerals and bone matric in equal proportions (Hinjorgo *et al.,* 2008). These results are similar to the study of Hedley *et al.* (2004) observed that the association between age and weight gain and found that as age increases the metabolic rate decreases and fat formation and deposition in adipose tissues also increased which leads to weight gain.

Height basically strongly linked to inherited factor measured in centimeters (cm) and is not fluctuated by other external or internal factors. So the results of present study showed that there was non-significant relationship between height and age of osteoporosis. Maximum values of height were found in age group 56-60years and minimum in 51-55 years as compared to 45-50 years as studied by (Benn, 1971).

Lean mass peaks in the third to fourth decade of life, followed by a steady decline with advancing age. Muscles exert mechanical stress on bone and therefore act positively on bone mass (Harris and Hughes, 1996). Gnudi *et al*. (2007) observed that in osteoporotic women lean mass (muscle mass) was significantly along with individually connected with BMD. Even so the relationship association of with muscle tissue with bone mineral thickness in osteoporotic women of all ages ended up being under observed in women of all ages without having weakening of bones as a result of lower mass which will always be connected to a smaller amount effective muscle tissue stimulation with bone.

These results are similar to the results of study of Hughes *et al*. (2002) who observed that increase in fat mass is associated with increase in age. Hsu *et al.* (2006) found a negative relationship between fat mass and bone mass. It was observed that the risk of osteopenia and osteoporosis were significantly higher in individual with higher percentage of body fat. Fat mass is inversely correlated with bone mass (Zhao *et al.,* 2007).

The results are in close agreement to the findings of Khatak *et al*. (2013) who studied the prevalence of osteoporosis in aging women and found significant association between postmenopausal age and BMD. BMD scores were low in postmenopausal women according to T- score along with decreased Serum calcium level with respect to age. Similarly Siris *et al.* (2001) examined the occurrence of low bone mineral density and its risk factors in post-menopausal women. Age, smoking and family history of fracture were

Table 1: Mean ± SE of weight, height, body mass index, body muscle, body fat, bone mineral density, calcium and phosphorus compared with age in post-menopausal women.

Parameters	Age (years)			Overall Means
	45-50	51-55	56-60	
Weight (kg)	65.01±1.00^{c}	67.49±2.07^{b}	73.44±2.60^{a}	68.65±1.30
Height (cm)	4.87±0.17	4.62±0.18	5.03±0.17	4.84±0.10
BMI (kg/m^2)	32.30±2.02	30.30±1.52	29.17±1.19	30.59±0.93
Body Muscle **(%)**	27.43±0.35^{a}	26.65±0.34^{ab}	25.59±0.34^{b}	26.56±0.24
Body Fat **(%)**	36.48±0.19^{c}	40.33±1.08^{b}	46.14±0.51^{a}	40.98±0.83
Bone Mineral Density	-0.81±0.33^{c}	-1.97±0.26^{b}	-2.81±0.11^{a}	-1.86±0.21
Calcium (mg/dL)	8.70±0.11^{a}	8.23±0.08^{b}	8.18±0.19^{c}	8.37±0.09
Phosphorus (mg/dL)	5.52±0.23^{c}	6.02±0.23^{b}	6.63±0.30^{a}	6.06±0.16

Mean sharing similar letter in a column are statistically non-significant ($P>0.05$)

Table 2: Correlation between age and weight, height, body mass index, body muscle, body fat, bone mineral density, calcium and phosphorus compared with age in post-menopausal women.

	Age	Weight	Height	BMI	BM	BF	BMD	Calcium	Phosphorus
Age	1								
Weight	0.482** (P<0.007)	1							
Height	0.123 (P<0.516)	0.115 (P<0.545)	1						
BMI	-0.250 (P<0.183)	0.286 (P<0.126)	-0.122 (P<0.521)	1					
Body muscle	-0.624** (P<0.000)	-0.374* (P<0.042)	0.125 (P<0.512)	-0.180 (P<0.341)	1				
Body fat	0.865** (P<0.000)	0.634** (P<0.000)	0.102 (P<0.592)	0.039 (P<0.837)	-0.660** (P<0.000)	1			
Bone Mineral density	-0.743** (P<0.000)	-0.453* (P<0.012)	-0.036 (P<0.851)	0.029 (P<0.878)	0.465** (P<0.010)	-.692** (P<0.000)	1		
Calcium	-0.429* (P<0.018)	-0.260 (P<0.165)	-0.351 (P<0.057)	0.251 (P<0.180)	0.129 (P<0.498)	-0.330 (P<0.075)	0.361 (P<0.050)	1	
Phosphorus	0.505** (P<0.004)	0.439* (P<0.015)	0.159 (P<0.400)	-0.090 (P<0.638)	0.043 (P<0.823)	0.422* (P<0.020)	-0.493** (P<0.006)	-0.499** (P<0.005)	1

*, ** show significantly different at P<0.05 and P<0.01

Table 3: Mean ± SE of age, weight, height, body mass index, body muscle, body fat, bone mineral density, calcium and phosphorus compared with bone mineral density in post-menopausal women.

Parameters	Normal Bone (BMD>-1.0)	Osteopenia (BMD -1.0 to -2.5)	Osteoporosis (BMD<-2.5)	Overall Means
Age (years)	47.40±1.36^{c}	52.00±1.17^{b}	57.11±0.84^{a}	52.77±0.92
Weight (kg)	64.96±0.92	67.39±1.45	72.93±3.08	68.65±1.30
Height (cm)	4.82±0.29	4.77±0.13	4.99±0.18	4.84±0.10
BMI (kg/m^2)	33.40±3.57	29.43±1.21	31.09±1.10	30.59±0.93
Body Muscle (%)	26.98±0.50	26.84±0.38	25.82±0.14	26.56±0.24
Body Fat (%)	37.38±1.09^{b}	39.68±0.99^{ab}	45.31±1.08^{a}	40.98±0.83
Calcium (mg/dL)	8.70±0.24^{a}	8.41±0.08^{b}	8.11±0.19^{c}	8.37±0.09
Phosphorus (mg/dL)	5.38±0.29^{c}	5.94±0.20^{b}	6.63±0.31^{a}	6.06±0.16

Mean sharing similar letter in a column are statistically non-significant (P>0.05)

Table 4: Mean ± SE of age, height, body muscle, body fat, bone mineral density, calcium and phosphorus compared with body mass index in post-menopausal women

Parameters	Normal	Over Weight	Obese	Overall Means
Age (Years)	53.00±3.61	54.17±2.21	51.41±1.18	52.23±0.99
Weight (Kg)	53.43±3.19	68.95±1.81	79.60±2.46	74.12±2.41
Height (cm)	4.90±0.40	5.18±0.07	4.72±0.15	4.85±0.11
Body Muscle (%)	27.67±0.45	28.13±0.89	26.76±0.26	27.18±0.28
Body Fat (%)	33.37±1.85	38.43±0.64	42.88±0.51	40.75±0.76
Bone Mineral Density	-1.77±0.22	-1.88±0.58	-1.66±0.29	-1.73±0.23
Calcium (mg/dL)	8.20±0.51	8.60±0.22	8.57±0.26	8.53±0.18
Phosphorus (mg/dL)	6.17±0.55	5.95±0.34	6.08±0.25	6.06±0.18

Mean sharing similar letter in a column are statistically non-significant (P>0.05)

related with increase prevalence of osteoporosis while exercise, higher BMI, estrogen use and alcohol consumption decreased the risk of osteoporosis. Reginster and Burlet (2006) found that in older adults the pervasiveness of osteoporosis is enduring to escalate with increasing age.

Khatak *et al*. (2013) found that there was increase in BMI with age in postmenopausal women. Bukhar *et al.* (2012) found that the subjects with osteoporosis had statistically higher BMI compared with osteopenia and normal women. Asomaning *et al*. (2006) conducted a study on women with osteopenia/ osteoporosis to find out the association between body mass index and bone mineral density. This study showed an inverse relationship between BMI and BMD status.

This study showed that the serum calcium decreased due to increase in age of osteoporosis aging women. The similar results have been found by Khatak *et al.* (2013) who reported that the level of serum calcium was declined significantly in post-menopausal women with respect to their age. The mean of serum calcium was 8.34±0.47. Same result were reported by Gallagher *et al*. (1979) that intestinal calcium absorption decreases with aging in post-menopausal women and results in decreased serum calcium level.

These results are similar to the findings of Gallagher *et al*. (1979) who observed that in osteoporotic women serum calcium or active parathyroid hormone was moreover normal or low comparative to age matched controls and

imply serum phosphorus was improved. Jowsey *et al*. (1974) reported that high phosphate levels in the blood trim down the formation of the active structure of vitamin D (calcitriol) in the kidneys, decrease blood calcium, and lead to increased PTH release by the parathyroid glands. If sustained, elevated PTH levels could have an undesirable effect on bone mineral content.

CONCLUSION

Body muscles, bone mineral density and serum calcium decrease with age in post- menopausal women. Body fat and serum phosphorus increases with age in post -menopausal women. Body mass index and height had non-significant association with age and osteoporosis. It was concluded that body weight, body muscles, body fat, bone mineral density, serum calcium and phosphorus had significant association with age and osteoporosis.

ACKNOWLEDGEMENT

Special thanks to Mr. Amanat Ali who assisted for the statistical work, typing of this manuscript, and formatting of this paper.

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